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PATENT ABSTRACTS OF JAPAN

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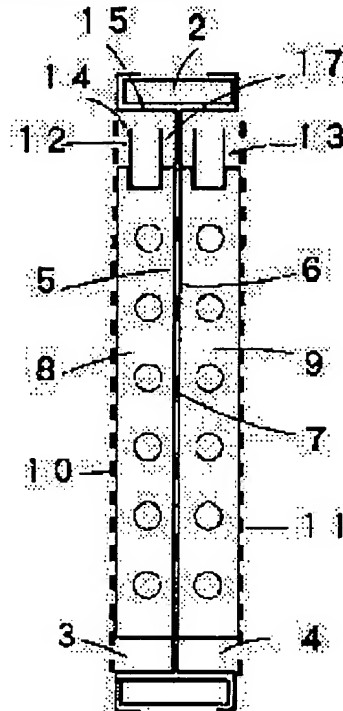
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(54) GAS LIQUID SEPARATION IN ION-EXCHANGE MEMBRANE ELECTROLYTIC CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent the pressure fluctuation in an electrode compartment and the vibration of an ion-exchange membrane due to the fluctuation by allowing a gas-liq. mixture generated in the compartment to ascend in a small cross-sectioned passage parallel to the electrode face formed at the upper part of an electrolytic cell and separating liq. from gas through a gap.

SOLUTION: The U pipelines 12 and 13 provided at the upper part of an electrode compartment are set apart from the anode 10, cathode 11 and partition wall 5. A narrow gap into which the ascending electrolyte and bubble flow is formed between the side wall 14 of the pipelines 12 and 13 on the electrode- face side and the upper wall 15 of the compartment, and a communicating passage 17 is provided in the wall of the pipelines 12 and 13 on the partition wall 5 side. Consequently, the bubble in the mixture is sent upward in the narrowed passage, compressed, joined to the nearby bubble and enlarged, the enlarged bubbles are then introduced into the pipeline from the narrow gap, compressed and expanded by the pressure fluctuation during its flowing and mostly burst, and the bubbles are separated.



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CLAIMS

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[Claim(s)]

[Claim 1] The vapor-liquid-separation method in the ion-exchange-membrane cell characterized by performing vapor liquid separation by emitting from a gap with reduced pressure by the discharge from compression by inflow to the path where the cross section is small, and a gap after are parallel to the electrode side which formed in the cell upper part the vapor-liquid mixture generated in the electrode interior of a room in the vapor-liquid-separation method in an ion-exchange-membrane cell and raising the path where the cross section is small.

[Claim 2] The vapor-liquid-separation method in the ion-exchange-membrane cell according to claim 1 characterized by being detached by vapor-liquid in case a gap is formed between the side attachment wall of U type duct, and the wall surface prepared in the upper part of U type duct and is emitted to U type duct, while one field of the path formed in the cell upper part is formed of the side attachment wall of U type duct in which the upper part carried out opening.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the vapor-liquid-separation method of performing vapor liquid separation in the electrode room upper part of the electrolytic solution containing the foam especially generated by the electrolysis reaction like the ion-exchange-membrane-process chlorination alkali cell, about the vapor-liquid-separation method in a cell.

[0002]

[Description of the Prior Art] The ion-exchange-membrane-process filter press type cell is widely used for organic electrolysis including manufacture of the chlorine by electrolysis of brine, and caustic alkali of sodium, seawater electrolysis, etc. A filter press type cell minds conductive member for the septum of an anode plate room and a cathode room. Or pinch a cation exchange membrane and the laminating of many double pole type cell units combined electrically and mechanically by meanses, such as a pressure welding, is carried out. There is a double pole type filter press type cell which carried out the laminating of the edge cell unit which has either an anode plate or cathode on one side to ends, and was fixed with a hydraulic press etc. Moreover, the laminating of many the anode plate room units and cathode room units which have an anode plate or cathode is carried out to both sides of a frame-like electrode room frame through a cation exchange membrane, and there is a unipolar-system filter press type cell which carried out the laminating of the edge pole room unit to which only one side has an anode plate or cathode in both ends.

[0003] Since a high-concentration sodium hydroxide and high-concentration hydrogen generate by cathode by chlorine gas occurring in an anode plate in an ion-exchange-membrane-process brine electrolysis tub, the outstanding titanium of the corrosion resistance which forms a passivation coat stable on a front face, or its alloy is used for an anode plate room, it replaces with the titanium which absorbs and stiffens hydrogen in a cathode room, and the metal of iron systems, such as alkali-proof nickel and stainless steel, or its alloy is used. Moreover, an anode plate and cathode are attached in the electric conduction rib combined with the septum, and the exhaust nozzle of the electrolytic solution to which an electrolytic-solution supply nozzle and concentration fell or rose, the gas which is the product of an electrolysis reaction, and the electrolytic solution which mixed the foam is prepared in each electrode room at the side attachment wall.

[0004] The anode plate which covered the oxide of the metal of platinum groups, such as a ruthenium, iridium, and palladium, etc. on the front face by making perforated plates, such as titanium, an expanded metal, etc. into a base material at the anode plate is used. The cathode which covered the front face with cathode catalyst matter, such as a nickel system and a platinum metal system, is used at cathode by making perforated plates, such as iron, stainless steel, or nickel, an expanded metal, etc. into a base material. Moreover, the cation exchange membrane of the fluororesin system which has a sulfonic group, a carboxylic-acid machine, etc. is used for ion exchange membrane.

[0005]

[Problem(s) to be Solved by the Invention] In a filter press formula ion-exchange-membrane-process cell, if the electrolysis reaction which a gas generates like electrolysis of salt is performed, when extracting the anolyte or catholyte containing a foam from an electrode room, change of the electrode internal pressure force resulting from a foam arises.

[0006] Electrode indoor the anolyte or catholyte of the chlorination alkali cell of a vertical mold generally used will form the gaseous phase which consists of a gas which foams gathered, became a bubble layer and was separated into the topmost part from the bubble, if a foam comes out comparatively, a certain void volume increases and the upper part becomes near the management of electrode room liquid with the foam generated in the electrode. Consequently, it will flow out, if it is going to discharge the electrolytic solution and a generating gas from the electrode room upper part, and a state produces the complicated flow which fluctuates the electrode internal pressure force by the bubble flow with which a vapor-liquid mixed phase, the liquid phase, and the gaseous phase mingled, the plug style which blockades a duct, the wavelike style, etc. It originates in salt water viscosity, surface tension, etc., a foam cannot disappear easily compared with the hydrogen foam formed from caustic alkali of sodium and hydrogen by the cathode room side, and the chlorine foam formed especially by the anode plate room side causes the pressure fluctuation of the anode plate interior of a room. For this reason, although the pressure fluctuation of the anode plate interior of a room changes with electrolytic conditions, depending on 50-200mmH₂O and the case, it is 300mmH(s)2O. It happens that always vibrate ion exchange membrane, contact an electrode side, or repeat [exceed,] to separate, and produce the blemish by friction on the front face of a cation exchange membrane, and a crack arises in a cation exchange membrane for defatigation by vibration. Consequently, while the property of a cation exchange membrane deteriorates, generally, the pressure of the electrode

interior of a room will produce the injury on the electrode by the alkali which flows into the anode plate interior of a room from the high cathode interior of a room, and will have a bad influence on the life of an electrode.

[0007] Then, it sets to the ion-exchange-membrane-process cell of brine. How to keep the pressure of a cathode room larger than the change maximum of the anode plate room pressure force, to always stick a film to an anode plate side by pressure, and to prevent vibration, Prepare a chamber higher than an electrolyte level in the electrode room upper part, and a vapor-liquid separated zone is formed in a chamber. How to carry out natural defoaming into a chamber and take out from the exhaust nozzle of a side attachment wall as a wavelike style and a stratified flow, The method of preparing the nozzle to which the ***** room upper wall shown in JP,2-17013,U is made to carry out opening to the interior of 30mm or more, and the liquid rate of flow in a nozzle becomes it from the inside in 0.5 or 20m/[a second and] etc. is proposed.

[0008] However, the method of adding a larger pressure than the maximum of anode plate room pressure force change to a cathode room always sticks by pressure the anode plate front face where a film consists of an expanded metal or a perforated plate too much. In order to eat into the aperture of an anode plate, the anode plate overvoltage of chlorine generating is enlarged and number -about tenmV of electrolytic voltages is raised. it not only causes loss of power, but If it sees in the long run, there is a fault to which the corrosion of catalytic activity covering of the anode plate by the alkali which carries out reverse migration also shortens the life of an electrode greatly as compared with the case where the pressure of cathode pressurization is small, from a cathode side.

[0009] The method of making the upper part of an electrode room high and preparing a vapor-liquid separated zone is disagreeable ***** from which the cost of materials of the increment of the capacity of an electrode room and a conversion cost become expensive although it is effective in pressure fluctuation prevention. Furthermore, since the method of inserting an exhaust nozzle from the wall surface of the upper part of an electrode room needs to define the size of an exhaust nozzle etc. with the ratio of generating capacity and the circulating load of the electrolytic solution in the electrode interior of a room, its flexibility of operation of a cell is small, and in especially a double pole type cell, the cure of the corrosion prevention by the leakage current which flows through an exhaust nozzle is needed.

[0010] Furthermore, since a cation exchange membrane receives a bad influence by the chlorine of the shape of a gas which penetrates a cation exchange membrane by the method by the exhaust nozzle by the front face of the ion exchange membrane of the upper part of an electrode room being in dryness The required thing for which the weir as for which the electrolytic solution for holding a cation-exchange-membrane front face to a damp or wet condition carries out an overflow is established in the septum side of the upper part of an electrode room by welding etc. is clarified ("soda and chlorine" the 18th page of the 4 volume [41st] No. (April, 1990)).

[0011] On the other hand, although it is the desirable manufacture method since the method of manufacturing the electrode room of the shape of a pan of a double pole type cell by the die press using sheet metal, such as titanium, nickel, and stainless steel, is easy to manufacture, and mass-production nature is size and it is very effective in the cost reduction of a cell, a vapor-liquid-separation chamber will be added to this, or attaching a weir etc. by welding will lose the feature of press molding.

[0012]

[Means for Solving the Problem] In the vapor-liquid-separation method in an ion-exchange-membrane cell, this invention is parallel to the electrode side which formed in the cell upper part the vapor-liquid mixture generated in the electrode interior of a room, and after it raises the path where the cross section is small, it is the vapor-liquid-separation method in the ion-exchange-membrane cell which performs vapor liquid separation with reduced pressure by the discharge from compression by inflow to the path where the cross section is small, and a gap by emitting from a gap. Moreover, while one field of the path formed in the cell upper part is formed of the side attachment wall of U type duct in which the upper part carried out opening, in case a gap is formed between the side attachment wall of U type duct, and the wall surface prepared in the upper part of U type duct and is emitted to U type duct, it is the vapor-liquid-separation method in the ion-exchange-membrane cell detached by vapor-liquid.

[0013]

[Embodiments of the Invention] The vapor-liquid-separation method of this invention is parallel to the electrode side which formed in the cell upper part the vapor-liquid mixture generated in the electrode interior of a room, and after it raises the path where the cross section is small, it is the vapor-liquid-separation method in the ion-exchange-membrane cell which performs vapor liquid separation with reduced pressure by the discharge from compression by inflow to the path where the cross section is small, and a gap by emitting from a gap. And with the duct in which the U character-like upper surface carried out [the cross section prepared in the upper part of an electrode room] opening, as a result of narrowing the up space of an electrode room, the passage of the electrolytic solution containing a foam becomes narrow, and a foam carries out contact coalescence expansion, is compressed from the narrow gap formed between the wall surface of the upper part of an electrode room, and the side attachment wall of a duct, and flows into a duct. The electrolytic solution and the gas containing the bubble which many of foams expanded at the time of an inflow explode by change of compression and a pressure, and remains the inside of a duct flow toward an exhaust nozzle. Moreover, when a foam is blockaded by the bubble in a duct, a gas can be made to be able to flow into the space formed between U type duct and the septum of the free passage way established in the side attachment wall of a duct, and an exhaust nozzle can be made to bypass.

[0014] With reference to a drawing, this invention is explained further below at a detail. Drawing 1 is drawing showing one example of the cell used for the vapor-liquid-separation method in the ion-exchange-membrane cell of this invention, the plan which cut and lacked a part of double pole type cell unit is shown, and drawing 2 shows the cross section which cut drawing 1 by the A-A line. The cell unit 1 of a double pole type makes a skeleton the frame-like frame 2 fabricated with the rigid bodies, such

as carbon steel, and the anode plate room 3 and the cathode room 4 are formed in right and left. The septum 5 by the side of the anode plate room which processed sheet metal, such as titanium or a titanium alloy, in the shape of a pan, and the septum 6 by the side of the cathode room which processed sheet metal, such as iron, stainless steel, and nickel, in the shape of a pan similarly are combined electrically [in a bond part 7] and mechanically. The anode plate 10 in which covering which contains the metal or oxide of a platinum group to the electric conduction ribs 8 and 9 combined with the septum, respectively was formed, and the cathode 11 which covered the cathode active substance of a nickel system and a platinum-group system are attached in the anode plate room and the cathode room, and U type ducts 12 and 13 are formed in the upper part of an electrode room. U type duct prepares an electrode and a septum, and an interval, and is attached, the narrow gap 16 where the electrolytic solution and the foam which went up flow is formed between the side attachment wall 14 by the side of the electrode side of U type duct, and the up wall 15 of an electrode room, and the free passage way 17 is established in the wall surface by the side of the septum of U type duct.

[0015] Moreover, the end of U type duct is combined with the exhaust nozzle 19 for taking out to the exterior the electrolytic solution and the gas which were attached in the side-attachment-wall section 18 of a cell unit, the supply nozzle 20 of the electrolytic solution is attached in the lower part of a cell unit, and the installation arm which attaches a cell unit in a stand is prepared in the side attachment wall of a cell unit.

[0016] Drawing 3 shows drawing which attaches U type duct in the interior of a cell from the exhaust nozzle of the electrolytic solution. U type ducts 12 and 13 are attached in the exhaust nozzle 19 prepared in the side-attachment-wall section 18 of a cell unit. In order to prevent the electric corrosion in the inside of a cell, as for U type duct, it is desirable to use synthetic resin, such as a fluororesin and polypropylene. U type duct is attached in the exhaust nozzle 19 through the gasket 21, and forms the notching section 22 used as the guide of U type duct in the electric conduction rib 8 which attaches an electrode. Moreover, the free passage way 17 is established in the side attachment wall of U type duct.

[0017] Drawing 4 is drawing showing the cell of a double pole type, it is assembled from the cell unit 1, the edge anode plate unit 23, and the edge cathode unit 24 of five double pole types, and a cation exchange membrane 25 is attached between each cell unit, and it lays in a stand 26, and is fixing by the hydraulic press, the tie rod, etc., and combines a duct with the exhaust nozzle 19 of a cell unit side attachment wall, and the supply nozzle 20, and supplies the electrolytic current to the cell unit of both ends

[0018] Drawing 5 is drawing explaining the flow of the electrolytic solution to U type duct formed in the cell. U type duct needs the length between the both-sides walls of an electrode room, and the ****ing height, in order to hold an oil level 28 to the septum side space 27 of an electrode room and to form gaseous bypass passage in it, while balance-izing the upflow of the electrolytic solution of a vapor-liquid mixed phase state over the whole electrode room. Moreover, it is required for the height of the side attachment wall of a U type duct, the distance, i.e., the height, which promotes coalescence of a foam on the elevation way of the electrolytic solution by the side of an electrode, and it turns out preferably to the oil-level depth of a cell that it is the need 5% or more 4% or more in the result searched for by the experiment under a standard electrolytic condition with current density 3 kA/m², a temperature [of 85 degrees C], and a salt water concentration of 200g [/l.]

[0019] Although the electrolysis space section 29 of an anode plate room is a field which is carrying out free elevation of the inside of the salt water of the electrolytic solution although a chlorine foam group receives a complicated flow resistance, if a upflow reaches the portion divided by U type duct, to most foams going into the passage of the electrode side space 30, and going up with liquid, there will be no elevation of vapor-liquid in the septum side space 27, and an oil level 28 will be formed. In order to form an oil level 28 in septum side space and to form a upflow in electrode side space, it is required for the space by the side of an electrode to be larger than the space by the side of a septum more than double precision, the size of septum side space is so desirable that it is narrow in the range which does not produce capillarity, and it is desirable to be referred to as 2-4mm.

Moreover, a difference is formed in the height of the oil level of the both sides of U type duct as shown in drawing 5. The oil level of the space which this produced the difference in the density of the electrolytic solution of the field by the side of a septum and the density by the side of an electrode since the foam of a generating gas mainly went up in the electrode side in the electrode interior of a room, and was formed between U type duct and the septum as a result is because it is formed in the electrode side of U type duct.

[0020] The width of face of U type duct needs to form the passage cross section required to make the vapor-liquid corresponding to the electrolytic-solution amount of supply and a gaseous yield flow into a duct, and move it to an exhaust nozzle without derangement, and it is desirable to be referred to as 10mm or more. Moreover, although the flow passage area to which the electrolytic solution flows becomes large so that it is large, since it may become inadequate current distributing the height of U type duct to the electrode upper limit which leads a opposite side electric conduction rib, as for the height of U type duct, it is desirable to be referred to as 60-100mm. Especially in the cell shown in the example, since the space of a gaseous phase was prepared and the bypass of a generating gas was formed between U type duct and the septum, it becomes possible to make small width of face of U type duct.

[0021] Moreover, the vapor-liquid multiphase flow which went up electrode side space reaches the wall surface of the upper part of an electrode room. Into U type duct, although the electrolytic solution which it flowed into U type duct from the gap formed of the upper part of the side attachment wall by the side of the wall surface of the upper part of an electrode room and the electrode of U type duct, and many foams exploded on the occasion of passage of a gap, and included the end of a bubble is taken out from U type duct through an exhaust nozzle outside The gap formed between the side attachment wall of U type duct, and the up wall of an electrode room It is appropriate to be referred to as 3-6mm, and since passage resistance will become large and pressure fluctuation will become large conversely if set to 3mm or less, if a gap is large, it becomes large and is not desirable [it is desirable to be referred to as further 4-5mm and / the pressure fluctuation of the electrode interior of a room] preferably.

[0022] While the electrolysis method of this invention establishes the passage where vapor-liquid mixture with the small cross section goes up in the upper part of an electrode room. Since it was made to be emitted to the upper part of passage from a gap, the foam in vapor-liquid mixture in the narrowed passage. It is compressed going up, and it coalesces with a nearby foam, expands, and flows into a duct from a gap narrow subsequently, and in response to the compression in the case of an inflow, and the pressure variation of expansion, the many explode and are detached by vapor-liquid.

[0023]

[Example]

An anode plate room with a 93.5cm [140cm by] x depth of 3cm and a cathode room are cast with metal mold. a titanium board with an example 1 thickness of 1mm and a stainless steel board -- a press -- The thickness of 4mm which prepared notching for fixing U type duct to this in the upper limit, Are attached titanium with a width of face [of 3cm], and a length of 130cm, and a stainless electric conduction rib at intervals of 18cm from the center of electrode room breadth, and five are attached by welding. In the lower part of a two-poles room side attachment wall, with an electrode room and this quality of the material as an electrolytic-solution supply nozzle. The bore of 13mm, The short pipe with a flange with an outer diameter [of 17.3mm] and a length of 100mm was attached, and the square shape pipe with a flange with a 3cm [6.5cm by / thickness / of 1.5mm] / x length / of an electrode room and this quality of the material / of 10cm was welded and attached as an exhaust nozzle of the electrolytic solution and an electrolysis generation gas. Subsequently, the frame-like frame was unified, while soldering within the electric furnace using solder and combining the septum of a two-electrodes room as JP,3-240984,A indicates the clad object of the titanium and copper which attached frame-like a frame, an anode plate room, and a cathode room in the anode plate room side, and the septum by the side of a cathode room.

[0024] After an appropriate time, The numerical aperture obtained from the titanium board with a thickness of 1mm To 35% of expanded metal, a noble-metals oxide Vertical 1.399mx horizontal 0.933m electrolysis effective-area 1.3m² which gave anode plate activity covering to contain Gave activity cathode covering of a nickel system to the expanded metal of 37% of numerical apertures obtained from the stainless steel board with an anode plate (product made from Pel MEREKKU Electrode), and a thickness of 1.5mm. Spot welding of an anode plate and the cathode of this size was carried out to the electric conduction rib, and the double pole type cell unit was manufactured.

[0025] Moreover, the anode plate room and the cathode room manufactured the respectively independent edge anode plate unit and the edge cathode unit, formed the corrosion-resistant gasket for three double pole type cell units in the flange face, prepared the edge anode plate unit and the edge cathode unit in both ends, and pinched and carried out the laminating of the ion exchange membrane. The inter-electrode interval was set to 2mm, and assembled the double pole type cell which has four NafionN(s)954 (Du Pont tradename) as a cation exchange membrane. Subsequently, the thickness of 1.5mm made of a fluororesin, a height of 57mm, width of face of 18mm, The interval of the up wall surface of an electrode room and the side attachment wall of U type duct was set to 5mm for U type duct which has three 5mm holes on the side attachment wall by the side of a septum, it was 93mm in the overall length of 1025mm, and up opening length, the interval with an electrode side was inserted so that an interval with 8mm and a septum might be set to 4mm, and it combined with the nozzle for eccrisis.

[0026] It connected with the supervisor for electrolytic-solution supply, the electrolytic solution, and the supervisor for generation gas eccrisis through the flexible tube made of a fluororesin, and DC power supply, and the anode terminal of a cell and a cathode terminal were connected to each nozzle, and it was made to complete a cell. Pure water is supplied to a cathode room, the brine of 300 g/l is supplied to an anode plate room, the return brine of 200 g/l is taken [32% of caustic alkali of sodium] out for the brine concentration from an anode plate room from a cathode room, and they are the cell temperature of 85 degrees C, 5.2kA of electrolytic currents, and current density 3 kA/m². It energized and operated for 30 days. The generation current efficiency of caustic alkali of sodium in the meantime is average cell-voltage 3.05V of 96.2% and four pairs of cell units, and anode plate internal pressure force change is 15mmH(s)2O. It was in the state stabilized extremely less than. Subsequently, by returning current density 4 kA/m² and the salt water amount of supply for the purpose of the pressure fluctuation situation check in a heavy load electrolytic condition, and circulating salt water, it increases to the amount of two to 4 times of the standard amount of supply, anode plate internal pressure force change is measured, and a result is shown in Table 1. Moreover, operation of a cell was stopped, and although the cation exchange membrane was checked, abnormalities, such as discoloration and transformation, were not seen at all.

[0027] As a result of operating for 15 days on the same conditions as an example 1 except for the point of having attached U type duct which set the interval of the side attachment wall by the side of the electrode of U type duct of example 2 example 1, and the up wall surface of an anode plate room to 10mm, current efficiency was 95.6%, the average cell voltage was 3.06V, and the initial electrolysis performance was almost equivalent to the example 1. Change of anode plate internal pressure is measured like an example 1, and the result is shown in Table 1. Moreover, discoloration of 5mm of **** was seen by the upper part of the cation exchange membrane after shutdown.

As a result of operating for 15 days on the same conditions as an example 1 except for the point of having attached U type duct which set the interval of the side attachment wall by the side of the electrode of U type duct of example 3 example 1, and the up wall surface of an anode plate room to 15mm, current efficiency was 95.2%, the average cell voltage was 3.09V, and the initial electrolysis performance was almost equivalent to the example 1. Change of anode plate internal pressure is measured like an example 1, and the result is shown in Table 1. Moreover, the discoloration expected to be based on chlorine of 10mm of **** was observed by the upper part of the cation exchange membrane after shutdown.

[0028]

[Table 1]

Pressure fluctuation (mmH₂O)

A salt water flow rate The interval of U type duct side attachment wall and an up wall surface (A part for liter/ 5mm 10mm 15mm ----- 2 (1.5) 10 60 80 3 (2.3) 20 140 160 4 (3.1) 20 150 1805 (3.8) 30 180 190

ただし、表において、

供給塩水流量 + 戻り塩水流量

() 内は塩水循環倍率 =

供給塩水流量

[0029] From the cell of example of comparison 1 example 2, U type duct was removed, the re encrypt of a cell was performed using the cation exchange membrane used in the example 2, and it operated for 15 days on the same conditions as an example 2. As for current efficiency, electrolysis performance degradation was accepted by 3.11 V 94.8%, as for the average cell voltage. Moreover, anode plate internal pressure force - It is 10-120mmH₂O. It always changed in the range, and it was still larger than the example 2, the plug style arose in the exhaust nozzle, and the intermittent current appearance elephant was seen. When the cation exchange membrane was checked after the halt of operation, discoloration of the blackish brown of 100mm of **** was looked at by the upper part of a cation exchange membrane, and small blisters with a discoloration and a diameter of about 2mm were scattered under 35mm from the lower side of an exhaust nozzle, and the dark-brown discoloration and the scratch which are regarded as having touched the file-like activity cathode surface were seen in part.

[0030] It replaces with an example of comparison 2U type duct. the interval of a height of 57mm, and the upper limit of the L character type member of 18mm of breadth and an electrode room upper wall 5mm, After welding to the electrode room septum, having used the interval with an electrode as 8mm and attaching, The exhaust nozzle of an electrode room side attachment wall was converted, the exhaust nozzle with a bore [of 25mm] x outer diameter of 27.2mm was prepared in the position of a chest pars basilaris ossis occipitalis, the electrode was restored, it included in the cell, and others were operated for 15 days under the same standard electrolytic condition as an example 1. Current efficiency is 95.8%, a cell voltage is 3.08V, and it is ****. The electrode internal pressure force was sharply changed in the range of -20 - 180mmH₂ O, and the outflow state of the vapor-liquid from an exhaust nozzle was a typical intermittent plug style. Pressure fluctuation in the conditions which changed current density and the circulation scale factor 4 kA/m² and 3 times, respectively - It is 40-200mmH₂O. It increased. A dark-brown change regarded as having touched activity cathode was looked at by the upper part of the film which ****(ed).

[0031]

[Effect of the Invention] As explained above, after detaching the electrolysis method of this invention by vapor-liquid by emitting from a gap the interflow object of the electrolytic solution and generation gas generated in the electrode interior of a room after raising the passage where area is small, by emitting from an exhaust nozzle, it can prevent change of the pressure of the electrode interior of a room, and vibration of the ion exchange membrane by this, and can carry out reinforcement of ion exchange membrane and the electrode.

[Translation done.]

GAS LIQUID SEPARATION IN ION-EXCHANGE MEMBRANE ELECTROLYTIC CELL

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Inventor(s): GOTO HIROSHI
Applicant(s):: CHLORINE ENG CORP LTD
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EC Classification:
Equivalents: JP3110720B2

Abstract

PROBLEM TO BE SOLVED: To prevent the pressure fluctuation in an electrode compartment and the vibration of an ion-exchange membrane due to the fluctuation by allowing a gas-liq. mixture generated in the compartment to ascend in a small cross-sectioned passage parallel to the electrode face formed at the upper part of an electrolytic cell and separating liq. from gas through a gap.

SOLUTION: The U pipelines 12 and 13 provided at the upper part of an electrode compartment are set apart from the anode 10, cathode 11 and partition wall 5. A narrow gap into which the ascending electrolyte and bubble flow is formed between the side wall 14 of the pipelines 12 and 13 on the electrode- face side and the upper wall 15 of the compartment, and a communicating passage 17 is provided in the wall of the pipelines 12 and 13 on the partition wall 5 side. Consequently, the bubble in the mixture is sent upward in the narrowed passage, compressed, joined to the nearby bubble and enlarged, the enlarged bubbles are then introduced into the pipeline from the narrow gap, compressed and expanded by the pressure fluctuation during its flowing and mostly burst, and the bubbles are separated.

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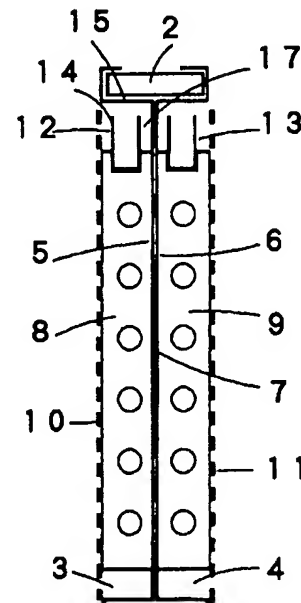
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(54) 【発明の名称】 イオン交換膜電解槽における気液分離方法

(57) 【要約】

【課題】 電極室内での圧力変動を減少させ、イオン交換膜の振動を防止する。

【解決手段】 イオン交換膜電解槽における気液分離方法において、電極室内で発生した気液混合物を、電解槽上部に形成した電極面に平行で、断面積が小さな通路を上昇させた後に、間隙から放出することによって、断面積が小さな通路への流入による圧縮と間隙からの放出による減圧によって気液分離を行うイオン交換膜電解槽による気液分離方法である。



【特許請求の範囲】

【請求項1】 イオン交換膜電解槽における気液分離方法において、電極室内で発生した気液混合物を、電解槽上部に形成した電極面に平行で、断面積が小さな通路を上昇させた後に、間隙から放出することによって、断面積が小さな通路への流入による圧縮と間隙からの放出による減圧によって気液分離を行うことを特徴とするイオン交換膜電解槽における気液分離方法。

【請求項2】 電解槽上部に形成した通路の一方の面が上部が開いたU型管路の側壁によって形成されるとともに、間隙がU型管路の側壁とU型管路の上部に設けた壁面との間に形成されたものであって、U型管路に放出される際に気液分離されることを特徴とする請求項1記載のイオン交換膜電解槽における気液分離方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は電解槽における気液分離方法に関し、とくにイオン交換膜法塩化アルカリ電解槽の如く電解反応によって発生した気泡を含む電解液の電極室上部において気液分離を行う気液分離方法に関する。

【0002】

【従来の技術】 イオン交換膜法フィルタープレス型電解槽は食塩水の電気分解による塩素と苛性ソーダの製造を始めとして、有機電解、海水電解等に広く用いられている。フィルタープレス型電解槽は陽極室と陰極室の隔壁を、導電部材を介して、あるいは圧接等の手段により電気的及び機械的に結合した複極式電解槽ユニットを陽イオン交換膜を挟持して多数積層し、両端には陽極あるいは陰極のいずれかを片面に有する端部電解槽ユニットを積層して油圧式プレス等で固定した複極式フィルタープレス型電解槽があり、また額縁状の電極室枠の両面に陽極もしくは陰極を有する陽極室ユニットと陰極室ユニットを陽イオン交換膜を介して多数積層し、両端部には片面のみ陽極または陰極を有する端部極室ユニットを積層した単極式フィルタープレス型電解槽がある。

【0003】 イオン交換膜法食塩電解槽においては陽極では塩素ガスが発生し、陰極では高濃度の水酸化ナトリウムと水素が生成するので陽極室には表面に安定な不動態化被膜を形成する耐食性の優れたチタンあるいはその合金を使用しており、陰極室には水素を吸収して脆化するチタンに代えて耐アルカリ性のニッケル、ステンレス等の鉄系の金属あるいはその合金を使用している。また、それぞれの電極室には隔壁に結合した導電リブに陽極と陰極を取り付けており、側壁には電解液供給ノズルと濃度が低下もしくは上昇した電解液、電解反応の生成物である気体、気泡を混合した電解液の排出ノズルが設けられている。

【0004】 陽極にはチタン等の多孔板、エキスパン

ジウム、パラジウム等の白金族の金属の酸化物等を被覆した陽極が用いられている。陰極には鉄、ステンレス又はニッケル等の多孔板、エキスパンデッドメタル等を基材として、その表面をニッケル系、白金族金属系等の陰極触媒物質によって被覆した陰極が使用されている。また、イオン交換膜には、スルホン酸基、カルボン酸基等を有するフッ素樹脂系の陽イオン交換膜が使用されている。

【0005】

【発明が解決しようとする課題】 フィルタープレス式イオン交換膜法電解槽において、食塩の電気分解などのように気体が発生する電気分解反応を行うと、気泡を含む陽極液又は陰極液を電極室から抜き出す時気泡に起因する電極室内圧力の変動が生じる。

【0006】 一般に用いられている縦型の塩化アルカリ電解槽の電極室内における陽極液又は陰極液は電極で発生した気泡によって上部ほど気泡の割合である気泡率が増大し、電極室液の上層部近くなると気泡が集合して泡沫層となり最上部に泡沫から分離した気体からなる気相を形成している。その結果、電極室上部より電解液及び発生気体を排出しようとする流出状態は気液混相、液相と気相が入り混じった気泡流、管路を閉塞するプラグ流、波状流などによる電極室内圧力を変動させる複雑な流れを生じる。特に陽極室側で形成される塩素気泡は、塩水粘度、表面張力などに起因して、陰極室側で苛性ソーダと水素から形成される水素気泡に比べて気泡が消えにくく、陽極室内の圧力変動を引き起こす。このため、陽極室内の圧力変動は、電解条件によって異なるが50～200mmH₂O、場合によっては300mmH₂Oを超え、イオン交換膜を常時振動させて電極面と接触したり離れることを繰り返し、陽イオン交換膜の表面に摩擦による傷を生じ、また振動による疲労のために陽イオン交換膜に亀裂が生じることが起こる。その結果、陽イオン交換膜の特性が劣化するとともに、一般には電極室内の圧力が高い陰極室内から陽極室内へ流入するアルカリによる電極の損傷を生じて電極の寿命に悪影響を及ぼすこととなる。

【0007】 そこで、食塩水のイオン交換膜法電解槽においては、陰極室の圧力を陽極室圧力の変動最大値より大きく保って膜を常時陽極面に圧着して振動を防止する方法、電極室上部に電解液面より高いチャンバーを設け、チャンバー内に気液分離ゾーンを形成し、チャンバー内において自然消泡して波状流、成層流として側壁の排出ノズルより取り出す方法、実開平2-17013号公報に示されている如き電極室上壁にその内面より30mm以上内部に開口させ、ノズル内の液流速が0.5ないし20m/秒となるノズルを設ける方法等が提案されている。

【0008】 しかしながら、陽極室圧力変動の最大値より大きい圧力を陰極室に付加する方法は膜がエキスパ

デッドメタルもしくは多孔板からなる陽極表面を常に過度に圧着し、陽極の開孔部に食い込むため塩素発生の陽極過電圧を大きくし電解槽電圧を数〜10数mV高めて電力の損失を招くだけでなく、長期的にみれば陰極側から逆泳動するアルカリによる陽極の触媒活性被覆の浸食も、陰極加圧の圧力が小さい場合に比して大きく電極の寿命を短くする欠点がある。

【0009】電極室の上部を高くして気液分離ゾーンを設ける方法は圧力変動防止に有効であるが、電極室の容量の増加分の材料費、加工費が高価となるきらいがある。さらに、電極室の上部の壁面より排出ノズルを差し込む方法は、発生ガス量と電極室内での電解液の循環量の比率によって、排出ノズルの大きさ等を定める必要があるために電解槽の運転の自由度が小さく、また複極式電解槽ではとくに、排出ノズルを通して流れるリーク電流による腐食防止の対策が必要となる。

【0010】さらに、排出ノズルによる方法では、電極室の上部のイオン交換膜の表面が乾燥状態となり、陽イオン交換膜を透過する気体状の塩素によって陽イオン交換膜が悪影響を受けるので、電極室の上部の隔壁面に陽イオン交換膜表面を湿潤状態に保持するための電解液の溢流する堰を溶接等によって設ける必要であることが明らかにされている（「ソーダと塩素」第41巻第4号第18ページ（1990年4月））。

【0011】一方、複極式電解槽の鍋状の電極室をチタン、ニッケル、ステンレス等の薄板を使用して金型プレスにより製作する方法は、製造が容易であり量産性が大であるため、電解槽のコスト低減に極めて有効であるので好ましい製作方法であるが、これに気液分離チャンバーを継ぎ足したり、堰等を溶接によって取り付けることはプレス成型の特徴を失うこととなる。

【0012】

【課題を解決するための手段】本発明は、イオン交換膜電解槽における気液分離方法において、電極室内で発生した気液混合物を、電解槽上部に形成した電極面に平行で、断面積が小さな通路を上昇させた後に、間隙から放出することによって、断面積が小さな通路への流入による圧縮と間隙からの放出による減圧によって気液分離を行うイオン交換膜電解槽における気液分離方法である。また、電解槽上部に形成した通路の一方の面が上部が開いたU型管路の側壁によって形成されるとともに、間隙がU型管路の側壁とU型管路の上部に設けた壁面との間に形成されたものであって、U型管路に放出される際に気液分離されるイオン交換膜電解槽における気液分離方法である。

【0013】

【発明の実施の形態】本発明の気液分離方法は、電極室内で発生した気液混合物を、電解槽上部に形成した電極面に平行で、断面積が小さな通路を上昇させた後に、間隙から放出することによって、断面積が小さな通路への

流入による圧縮と間隙からの放出による減圧によって気液分離を行うイオン交換膜電解槽における気液分離方法である。そして、電極室の上部に設けた断面がU字状の上面が開いた管路により、電極室の上部空間が狭められる結果、気泡を含む電解液の流路が狭くなり、気泡は接触合一拡大して、電極室の上部の壁面と管路の側壁との間で形成された狭い間隙から圧縮されて管路中へ流入する。流入の際拡大した気泡の多くは圧縮と圧力の変化によって破裂して管路内を残留する泡沫を含む電解液と気体が排出ノズルに向かって流れる。また、管路中において気泡が泡沫に閉塞された場合には管路の側壁に設けた連通路によってU型管路と隔壁との間に形成された空間へ気体を流入させ排出ノズルにバイパスさせることができる。

【0014】以下に図面を参照して、本発明をさらに詳細に説明する。図1は、本発明のイオン交換膜電解槽における気液分離方法に使用する電解槽の一実施例を示す図であり、複極式電解槽ユニットの一部を切り欠いた平面図を示し、図2は図1をA-A線で切断した断面図を示す。複極式の電解槽ユニット1は、炭素鋼等の剛体で成形された額縁状フレーム2を骨格として左右に陽極室3と陰極室4が形成されており、チタンまたはチタン合金などの薄板を鍋状に加工した陽極室側の隔壁5と鉄、ステンレス、ニッケル等の薄板を同様に鍋状に加工した陰極室側の隔壁6を結合部7で電気的および機械的に結合している。陽極室、陰極室には隔壁に結合した導電リブ8、9に、それぞれ白金族の金属あるいは酸化物を含む被覆を形成した陽極10とニッケル系、白金族系の陰極活性物質を被覆した陰極11が取り付けられており、電極室の上部にはU型管路12、13が設けられている。U型管路は、電極および隔壁と間隔を設けて取り付けられており、U型管路の電極面側の側壁14と電極室の上部壁15の間には、上昇した電解液および気泡が流入する狭い間隙16が形成されており、U型管路の隔壁側の壁面には連通路17が設けられている。

【0015】また、U型管路の一端は電解槽ユニットの側壁部18に取り付けた電解液および気体を外部へ取り出すための排出ノズル19に結合され、電解槽ユニットの下部には電解液の供給ノズル20が取り付けられており、電解槽ユニットの側壁には電解槽ユニットを架台に取り付ける取り付けアームが設けられている。

【0016】図3は、U型管路を電解液の排出ノズルから電解槽内部へ取り付ける図を示している。電解槽ユニットの側壁部18に設けた排出ノズル19にU型管路12、13を取り付けている。U型管路は電解槽中での電蝕を防止するために、フッ素樹脂、ポリプロピレン等の合成樹脂を用いることが好ましい。U型管路はガスケット21を介して排出ノズル19に取り付けられており、電極を取り付ける導電リブ8にはU型管路のガイドとなる切り欠き部22を形成している。また、U型管路の側

壁には連通路17が設けられている。

【0017】図4は、複極式の電解槽を示す図であり、5個の複極式の電解槽ユニット1と端部陽極ユニット23と端部陰極ユニット24から組み立てられており、各電解槽ユニットの間には、陽イオン交換膜25を取り付けて架台26に載置して油圧プレス、タイロッド等によって固定しており、電解槽ユニット側壁の排出ノズル19、供給ノズル20に管路を結合し、両端部の電解槽ユニットに電解電流を供給している。

【0018】図5は、電解槽に設けたU型管路への電解液の流れを説明する図である。U型管路は、電極室の全体にわたり気液混相状態の電解液の上昇流を均整化するとともに、電極室の隔壁側空間27に液面28を保持し、気体のバイパス流路を形成するためには、電極室の両側壁間の長さに対応する高さを必要とする。また、U型の管路の側壁の高さは電極側の電解液の上昇路において気泡の合一を促進する距離すなわち高さが必要であり、電流密度3kA/m²、温度85℃、塩水濃度200g/lの標準的な電解条件のもとでの実験により求めた結果では、電解槽の液面深さに対して4%以上好ましくは5%以上必要であることがわかった。

【0019】陽極室の電解空間部29は電解液の塩水中を塩素気泡群が複雑な流体抵抗を受けつつも自由上昇している領域であるが、上昇流がU型管路によって区切られた部分に達すると気泡の大部分は電極側空間30の流路に入って液と共に上昇するのに対し、隔壁側空間27には気液の上昇はなく液面28が形成される。隔壁側空間に液面28を形成し、電極側空間に上昇流を形成するためには、電極側の空間が隔壁側の空間より2倍以上大きいことが必要であり、隔壁側空間の大きさは毛細管現象を生じない範囲で狭い程好ましく、2~4mmとすることが好ましい。また、図5に示すように、U型管路の両側の液面の高さには差が形成される。これは、電極室内では電極側の方を主に発生気体の気泡が上昇するので、隔壁側の領域の電解液の密度と電極側の密度に差を生じ、その結果U型管路と隔壁との間に形成した空間の液面はU型管路の電極側に形成されるからである。

【0020】U型管路の幅は電解液供給量と気体の発生量に見合う気液を管路に流入させ、排出ノズルに混乱なく移動させるのに必要な流路断面積を形成することが必要であり、10mm以上とすることが好ましい。またU型管路の高さは、大きいほど電解液の流れる流路面積が大きくなるが、反面導電リブを通じての電極上端への電流分配が不十分となる可能性があるため、U型管路の高さは60~100mmとすることが好ましい。とくに、実施例に示した電解槽ではU型管路と隔壁の間に気相の空間を設けて発生気体のバイパスを形成したので、U型管路の幅を小さくすることが可能となる。

【0021】また、電極側空間を上昇した気液混相流は電極室の上部の壁面に達し、電極室の上部の壁面とU型

管路の電極側の側壁の上部によって形成された間隙からU型管路中へ流入し、間隙を通過の際に多くの気泡は破裂し、泡末を含んだ電解液がU型管路中へ、U型管路から排出ノズルを通じて外部へ取り出されるが、U型管路の側壁と電極室の上部壁との間で形成される間隙は、3~6mmとすることが適当であり、さらに4~5mmとすることが好ましく、3mm以下となると流路抵抗が大きくなり、逆に圧力変動が大きくなるので好ましくなく、間隙が大きいと電極室内の圧力変動が大きくなって好ましくない。

【0022】本発明の電解方法は、電極室の上部に断面積が小さな気液混合物が上昇する流路を設けるとともに、流路の上部には間隙から放出されるようにしたので、気液混合物中の気泡は狭められた流路で、上昇しながら圧縮されて、近傍の気泡と合体化して拡大し、次いで狭い間隙から管路中へ流入し、流入の際の圧縮と膨張の圧力変化を受けてその多くは破裂して気液分離される。

【0023】

【実施例】

実施例1

厚み1mmのチタン板とステンレス板をプレス金型により縦140cm×横93.5cm×深さ3cmの陽極室と陰極室を成型し、これにU型管路を固定するための切り欠きを上端に設けた厚み4mm、幅3cm、長さ130cmのチタン及びステンレスの導電リブを電極室横幅の中心から18cmの間隔で5本を溶接で取り付け、両極室側壁の下部に電解液供給ノズルとして電極室と同材質で内径13mm、外径17.3mm、長さ100mmのフランジ付短管を取り付け、電解液と電解生成気体の排出ノズルとして電極室と同材質の厚み1.5mm縦6.5cm×横3cm×長さ10cmのフランジ付角型パイプを溶接して取り付けた。次いで、額縁状の枠体と陽極室および陰極室を、陽極室側に取り付けたチタンと銅とのクラッド体と陰極室側の隔壁を特開平3-240984号公報に記載されているように、半田を用いて電気炉内でろう付けを行って両電極室の隔壁を結合するとともに額縁状の枠体を一体化した。

【0024】しかる後、厚み1mmのチタン板から得られた開口率が35%のエキスパンデッドメタルに貴金属酸化物を含有する陽極活性被覆を施した縦1.399m×横0.933m電解有効面積1.3m²の陽極（ベルメック電極（株）製）と厚み1.5mmのステンレス板から得られた開口率37%のエキスパンデッドメタルにニッケル系の活性陰極被覆を施した、陽極と同寸法の陰極を導電リブにスポット溶接して複極式電解槽ユニットを製造した。

【0025】また陽極室と陰極室がそれぞれ単独の端部陽極ユニットと端部陰極ユニットを製作し、3個の複極式電解槽ユニットをフランジ面に耐食性ガスケットを設

けて、両端部には端部陽極ユニットと端部陰極ユニットを設けてイオン交換膜を挟持して積層した。電極間隔は2mmとし、陽イオン交換膜としてNafion N954（デュボン社商品名）を4枚有する複極式電解槽を組み立てた。次いで、フッ素樹脂製の厚み1.5mm、高さ57mm、幅18mm、全長1025mm、上部開口部長さ93mmであり、隔壁側の側壁には5mmの孔を3個有するU型管路を、電極室の上部壁面とU型管路の側壁との間隔を5mmとし、電極面との間隔を8mm、隔壁との間隔を4mmとなるように挿入し、排出用ノズルと結合した。

【0026】各ノズルには、電解液供給用主管と電解液及び生成気体排出用主管にフッ素樹脂製フレキシブルチューブを介して接続し、直流電源と電解槽の陽極端子、陰極端子とを接続して電解槽を完成させた。陰極室には純水を供給し、陽極室には300g/lの食塩水を供給し、陰極室からは32%の苛性ソーダを、陽極室からは食塩水濃度を200g/lの戻り食塩水を取り出し、電解槽温度85℃、電解電流5.2kA、電流密度3kA/m²で通電し30日間運転した。この間の苛性ソーダの生成電流効率は96.2%、4対の電解槽ユニットの平均槽電圧3.05Vであり、陽極室内圧力変動は15mmH₂O以内で極めて安定した状態であった。次いで高負荷電解条件における圧力変動状況確認を目的として電流密度4kA/m²、塩水供給量を戻り塩水を循環さ*

圧力変動 (mmH₂O)
U型管路側壁と上部壁面との間隔
5mm 10mm 15mm

塩水流量 (リットル/分)	5mm	10mm	15mm
2 (1.5)	10	60	80
3 (2.3)	20	140	160
4 (3.1)	20	150	180
5 (3.8)	30	180	190

ただし、表において、
() 内は塩水循環倍率＝

供給塩水流量

【0029】比較例1

実施例2の電解槽よりU型管路を取り除き、実施例2で使用了陽イオン交換膜を使用して電解槽の再組立を行い、実施例2と同様の条件で15日間運転した。電流効率は94.8%、平均槽電圧は3.11Vで電解性能の低下が認められた。又、陽極室内圧力は-10～120mmH₂Oの範囲で常時変動し実施例2より更に大きく、排出ノズルにおいてプラグ流が生じ、間欠流出現象が見られた。運転の停止後に陽イオン交換膜を点検したところ、陽イオン交換膜の上部には幅約100mmの茶褐色の変色が見られ排出ノズルの下辺より35mm下まで変色と直径約2mmの小ブリストアが散在し、又やすり状の活性陰極表面に触れたと見られる黒褐色の変色と擦過傷が一部に見られた。

* せることにより標準供給量の2～4倍量に増加して陽極室内圧力変動を測定し、結果を表1に示す。また、電解槽の運転を停止して、陽イオン交換膜を点検したが変色、変質などの異常は全く見られなかった。

【0027】実施例2

実施例1のU型管路の電極側の側壁と陽極室の上部壁面との間隔を10mmとしたU型管路を取り付けた点を除いて、実施例1と同様の条件で15日間運転した結果電流効率は95.6%、平均槽電圧は3.06Vであり、初期電解性能は実施例1とほぼ同等であった。陽極室内圧の変動を実施例1と同様に測定し、その結果を表1に示す。また、運転停止後の陽イオン交換膜の上部には幅約5mmの変色が見られた。

実施例3

実施例1のU型管路の電極側の側壁と陽極室の上部壁面との間隔を15mmとしたU型管路を取り付けた点を除いて、実施例1と同様の条件で15日間運転した結果電流効率は95.2%、平均槽電圧は3.09Vであり、初期電解性能は実施例1とほぼ同等であった。陽極室内圧の変動を実施例1と同様に測定し、その結果を表1に示す。また、運転停止後の陽イオン交換膜の上部には幅約10mmの塩素によるとみられる変色が観察された。

【0028】

【表1】

【0030】比較例2

U型管路に代えて、高さ57mm、横幅18mmのL字型の部材の上端と電極室上壁との間隔を5mm、電極との間隔を8mmとして電極室隔壁に溶接して取りつけた上、電極室側壁の排出ノズルを改造して櫃底部の位置に内径25mm×外径27.2mmの排出ノズルを設け電極を修復して電解槽に組み込みその他は実施例1と同じ標準電解条件のもとで15日間運転した。電流効率は95.8%、槽電圧は3.08Vであつた。電極室内圧力は-20～180mmH₂Oの範囲で大きく変動し排出ノズルからの気液の流出状態は典型的な間欠のプラグ流であつた。電流密度および循環倍率を夫々4kA/m²、3倍に変えた条件での圧力変動は-40～200mmH₂Oに増加した。開槽した膜の上部には活性陰極に触れ

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たとえられる黒褐色の変化が見られた。

【0031】

【発明の効果】以上説明したように、本発明の電解方法は、電極室内で発生した電解液と生成ガスの混合流体を面積の小さな流路を上昇させた後に、間隙から放出することによって気液分離した後に排出ノズルから放出することによって、電極室内の圧力の変動とこれによるイオン交換膜の振動を防止し、イオン交換膜および電極を長寿命化することができる。

【図面の簡単な説明】

【図1】図1は、本発明のイオン交換電解槽における気液分離方法に使用する電解槽の一実施例を示す図である。

【図2】図2におけるA-A線の断面図である。

【図3】図3は、U型管路を電解槽ユニットの側壁から

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電解槽内部への取り付けを説明する図である。

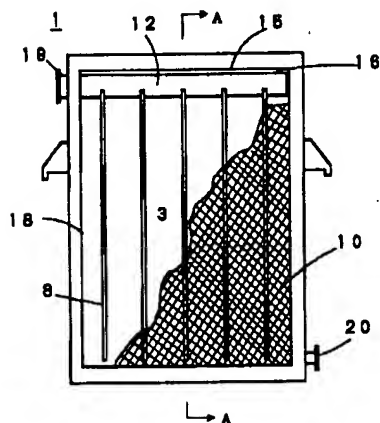
【図4】図4は、複極式の電解槽を示す図である。

【図5】図5は、電解槽に設けたU型管路への電解液の流れを説明する図である。

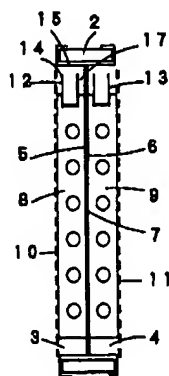
【符号の説明】

1…電解槽ユニット、2…額縁状フレーム、3…陽極室、4…陰極室、5…陽極室側の隔壁、6…陰極室側の隔壁、7…結合部、8、9…導電リブ、10…陽極、11…陰極、12、13…U型管路、14…U型管路の電極面側の側壁、15…電極室の上部壁、16…間隙、17…連通路、18…側壁部、19…排出ノズル、20…供給ノズル、21…ガスケット、22…切り欠き部、23…端部陽極ユニット、24…端部陰極ユニット、25…陽イオン交換膜、26…架台、27…隔壁側空間、28…液面、29…電解空間部、30…電極側空間

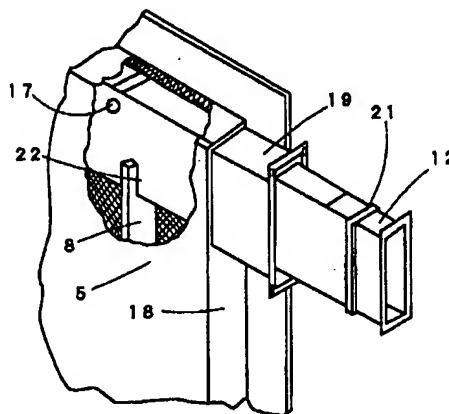
【図1】



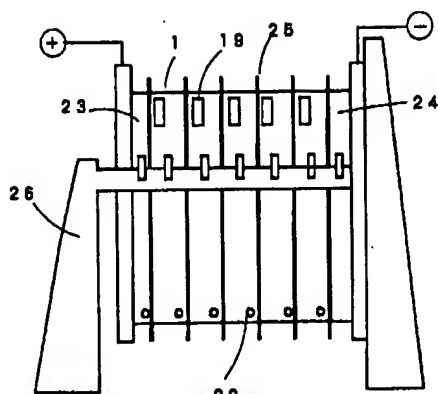
【図2】



【図3】



【図4】



【図5】

